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EXPERIMENTAL INVESTIGATION ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF DI-DIESEL ENGINE USING DIESEL- ETHANOL BLENDS AND ALUMINIUM OXIDE NANO PARTICLES

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ABSTRACT

An experimental investigation was carried out to evaluate the performance and emission characteristics of four stroke, single cylinder, constant speed diesel engine using aluminium oxide nano particles as additive in diesel ethanol blends compared with neat diesel. N-butanol (normal butanol) is used to prevent the phase separation between diesel and ethanol. 30nm sized aluminium oxide nano particle additives are used in every diesel and ethanol blends in the mass fraction of 50ppm.Final results are showing that the brake thermal efficiencies of the engine using diesel ethanol with nano additive blends are increased at higher loads compared to neat diesel and diesel-ethanol blends. Specific fuel consumption was slightly increased in diesel–ethanol blends compared to neat diesel due to lower heating value of ethanol. Emissions also controlled by using diesel, ethanol with nano additive blends compared to diesel-ethanol blends.

KEYWORDS: 4 Stroke Single Cylinder Diesel Engine, Ethanol, Diesel, Nano Particles, Performance & Emissions

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Original Article

INTRODUCTION

Compression ignition engines exhibits high thermal efficiency in automobile application, due to their fuel economy compared to petrol engines. These fossil fuels out send harmful pollutants like CO_2, Knox and other particulate matter. This causes greenhouse effects. Search for alternative fuels. Alternative fuels are one of the best available sources, to fulfill the energy requirement of the world. In this ethanol is one of the renewable sources. It is derived from biomass. It is environment friendly source. It reduces the emissions of the engine. However, slightly increases the fuel consumption, because of low calorific value. In this experiment, ethanol is an alternative fuel with diesel as different proportions like 15%, 25% and 35%, respectively. These fuel blends used in four stroke, single cylinder, constant speed direct injection diesel engine, to estimate the performance and emission characteristics. Alumina nano particles are also used in this work. These nano additives are used to reduce the emissions of an engine and increase the power output. Nano particles, improves the oxidation rates. Due to this, complete combustion takes place. Nano particles hold unusual properties, resulting from their high surface area. These are also improving the combustion efficiency, during the combustion process.

Studied the effects of diesel-ethanol, blends on the performance and emissions of direct injection diesel

engine. The brake thermal efficiency of the engine increases and specific Fuel consumption is decreased slightly, for ethanol-diesel blends [1]. Conducted the experiment, using cerium oxide nano particles in diesel and diesel-biodiesel-ethanol, blends on the performance and emissions and emission characteristics of diesel engines. Cerium oxide nano particles are used as an oxygen donating catalyst [2]. The vegetable methyl ester is used to prevent the phase separation, between diesel and ethanol. Co emissions decrease in diesel-biodiesel-ethanol blends and peak pressure also increases [3], studied the effects of alumina nano particle additive, on the performance and exhaust emissions of C.I engine. Al_20_3 improves the combustion characteristics of the engine, due to the rapid oxidation. These nano additives decrease the emissions of the engine and used for the complete combustion process [4], conducted the experiment on the DI-diesel engine, with the effects of different nano particles. The thermal efficiency of the engine increased and peak pressure was also increased, during this experiment. Zinc oxide and copper oxide nano particles are used in this work [5].

Studied the influence of alumina nano particles, on a single cylinder diesel engine, with cotton seed biodiesel blends, brake specific fuel consumption was decreased, with increase in brake power for diesel and other blends. Brake thermal efficiency also increased, with increase of brake power [6]. Conducted the experiment with the effects of Al_2O_3 nano particles, added to Mahua biodiesel blends on common rail direct injection diesel engine. The results are observed that, there is a significant enhancement in brake thermal efficiency and reduction of harmful pollutants [7], investigated the performance and emissions characteristics of a compression ignition engine, with cerium oxide nano additives to the diesel. It acts as catalyst and facilitates oxygen for the oxidation of CO, or absorbs oxygen for nitrogen oxide reductions [8], reviewed then on the result of aluminium oxide nano particles, ethanol and ISO propanol blend, as additive in diesel-soybean biodiesel blended fuel in diesel engine studied the performance, combustion and emission characteristics. Better mixing of nano particle additives, reduces the CO and unburned hydrocarbon emissions and a slight increase in nitrogen oxide emissions, at higher load conditions [9], studied the experiment investigated on the performance and emissions of the diesel engine, with the blends of diesel-ethanol [10], found that smoke emissions of the engine with ethanol, diesel were lower than the neat diesel fuel [11], investigated the effect of zinc oxide nano particles, added to the diesel-biodiesel-ethanol blends on the performance, emissions and combustion characteristics of diesel engines [12]. It is observed that, the brake thermal efficiency of the blends was lower than that of diesel, due to lower heating value of blends, as compared to diesel [13]. Reviewed on the effects of carbon nanotubes blended jatropha methyl ester emulsions. The test was conducted on a single cylinder, constant speed diesel engine [14] and observed that, the performance, emissions and combustion characteristics of the engine was analyzed [15]. The stability characteristics of the tested fuels were also studied [16].

PROPOSED WORK

This work proposes an experimental investigation on the performance and emission characteristics of the DI - diesel engine, using diesel-ethanol blends and alumina nano particle additives. The sequence of steps involved in this work is as shown in flow chart figure 1.

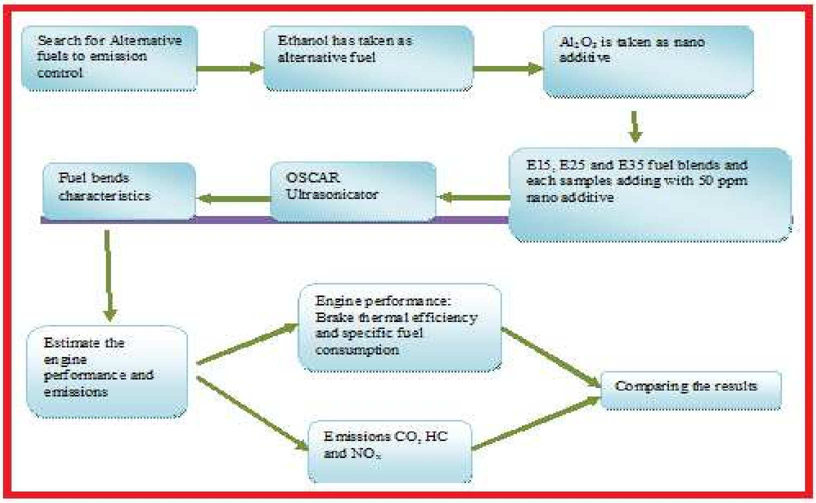

Figure 1: Flow Chart for Proposed Work

MATERIALS AND METHODS

We use ethanol as an alternate fuel in this experiment. By using this, blends are prepared; E15D85 (ethanol 15%, diesel85%), E25D75 (ethanol 25%, diesel 75%) and E35D65 (ethanol 35%, diesel 65%), respectively. This blend is as shown in figure 3. This blending process can be done by using a magnetic stirrer, as shown in figure 2. N-butanol (5% normal butanol) can be added for each blend, to prevent phase separation between diesel and ethanol.

Figure 2: Magnetic Stirrer

Figure 3: Samples of Fuel Blends E15D85, E25D75, E35D65

Preparation of Nano Fluid

Nano particle blended fuel samples are prepared by using an OSCAR ultrasonic sonicator, as shown in figure 4. Ultrasonic sonicator is used to disperse the nano particle in the fuel blend. The frequency of sonicator is 40KHZ. 50ppm nano additives are added to each blend. The fuel blends are E15D85+50ppm, E25D75+50ppm and E35D65+50PPM, respectively.

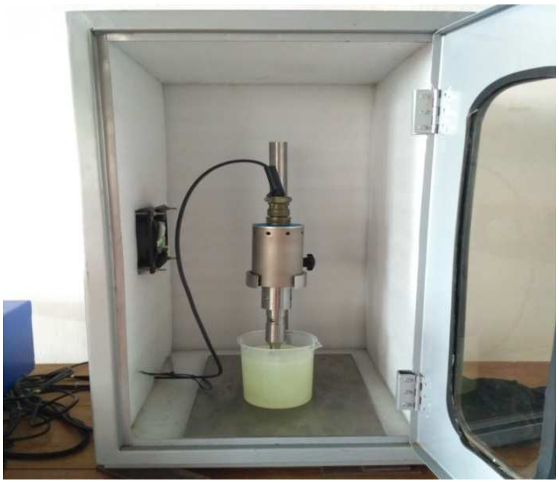

Figure 4: OSCAR Ultrasonic Sonicator

The following fuels calorific values are observed below table

Table 1: Calorific Values for Diesel- ethanol- Nano Additives

Fuel Samples	Calorific Value (kj/kg)
Diesel	44800
E15 D85	41268
E25 D75	39292
E35 D65	37516
E15D85+50ppm	42300
E25D75+50ppm	40300
E35D65+50ppm	38600

EXPERIMENTAL SETUP

First, check the engine condition along with lubricating oil and fuel is supplied to the engine. Start the engine and run initially for 10 minutes, to pick up the rated speed shown in figure 5, in this work conducted at different loads. The different loads are 0kg, 3kg, 6kg, 9kg and 12kg, respectively. In this, first neat diesel is applied to the four strokes, single cylinder diesel engine, to observe the performance and emission characteristics. Similarly, diesel-blends and diesel, ethanol with nano additive blends are applied to the engine at different proportions, and also estimate the performance and emissions of the specific engine.

Table 2: Specifications of the Engine

Type of Engine	Four Stroke, Vertical, Water Cooled, Single Cylinder High Speed Diesel Engine
Make and model	Kirloskar AVI
R.p.m	1500
Stroke	110mm
Diameter of rope	0.015m
Compression ratio	16.5 : 1
Brake power	3.75kw
Bore	80 mm
Diameter of brake drum	0.3 m
Loading system	Rope brake dynamometer

Figure 5: Single Cylinder Four-Stroke Direct Injection Diesel Engine

Figure 6: Gas Analyzer

RESULTS AND DISCUSSIONS

Performance Test

Brake Thermal Efficiency (BTE)

The variation of brake thermal efficiency versus load of neat diesel, E15D85, E25D75, E35D65, E15D85+50ppm, E25D75+50ppm and E35D65+50ppm relations, as shown in figure 7. In this observed we that, the brake thermal efficiency increases with increasing the loads. In diesel, ethanol with nano additive blend's thermal efficiency increases, compared to neat diesel and diesel-ethanol blends.

Specific Fuel Consumption (SFC)

Figure 8, shows the relationship between specific fuel consumption and loads of different blends. It is observed that, lower fuel energy consumption is 0.35kg/kw- her, for pure diesel in 12 kg load and higher fuel energy consumption is 1.22 kg/kw-HR, for E35 diesel-ethanol blend. Specific fuel consumption is slightly increased in diesel-ethanol blends, compared to neat diesel due to the lower heating value of diesel. Specific fuel consumption decreases with increasing the loads.

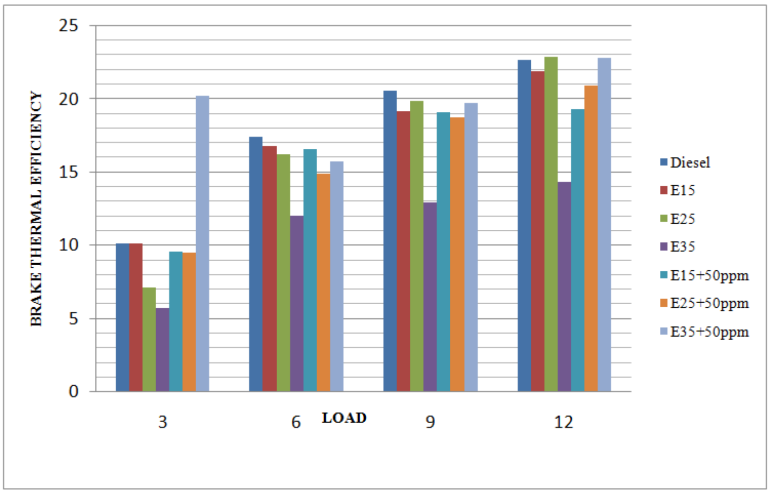

Figure 7: Load vs. Brake Thermal Efficiency

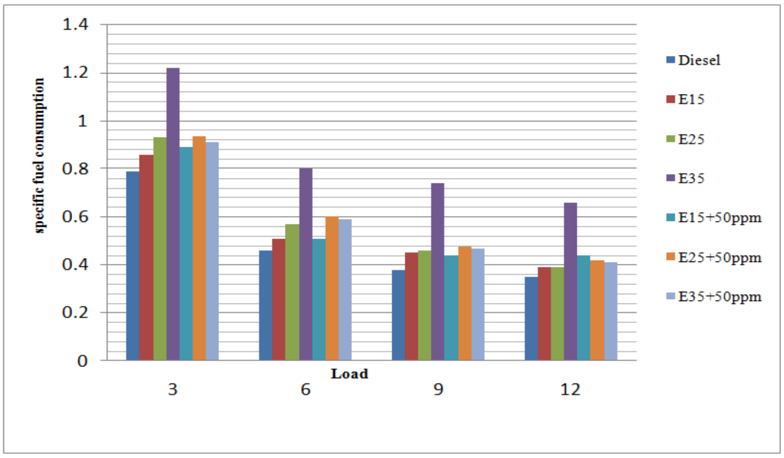

Figure 8: Load vs. Specific Fuel Consumption

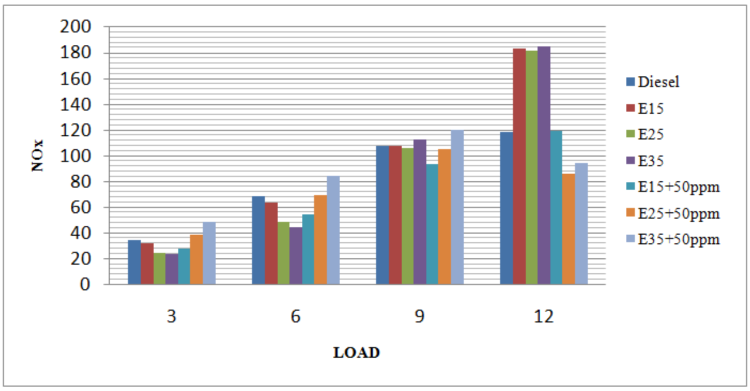

Figure 9: Load vs. NOx

Exhaust Emissions

NOX Emission

Figure 9, shows the variation of diesel, diesel, and ethanol with nano additive blends and without nano additive blends are applied on the four strokes, single cylinder diesel engine nitrogen oxide emissions at different loads are observed. The nitrogen oxide emissions are increasing, with increasing the loads on the engine for neat diesel and ethanol-

diesel blends, with and without the nano additives. Nitrogen oxide emissions are lower at low loads, for diesel-ethanol blends compared to other blends.

CO Emission

Figure 10, shows the relationship between CO emissions and loads for different blends. CO emissions are reduced at an engine Run, at half load condition for neat diesel, compared to other fuel blends. Co emissions are higher for diesel-ethanol blends, when compared to neat diesel and nano additive fuel blends.

HC Emission

Figure 10, shows the relationship between CO emissions and loads for different blends. CO emissions are reduced at an engine; run at half load condition for neat diesel, compared to other fuel blends. Co emissions are higher for diesel-ethanol blends, when compared to neat diesel and nano additive fuel blends.

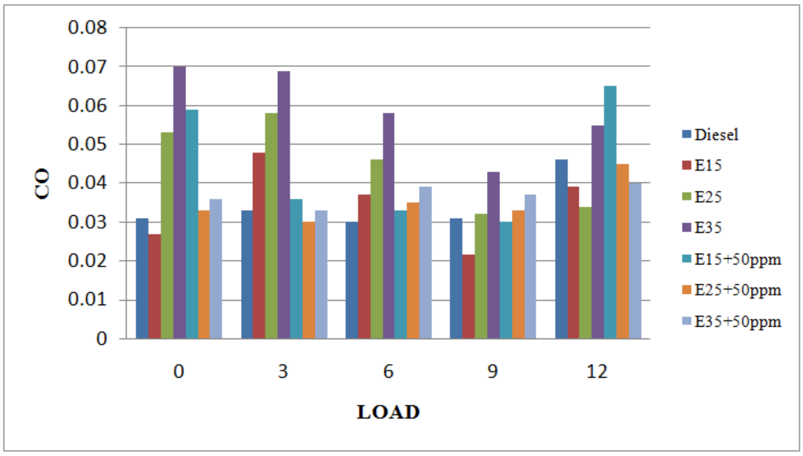

Figure 10: Load vs. CO Emission

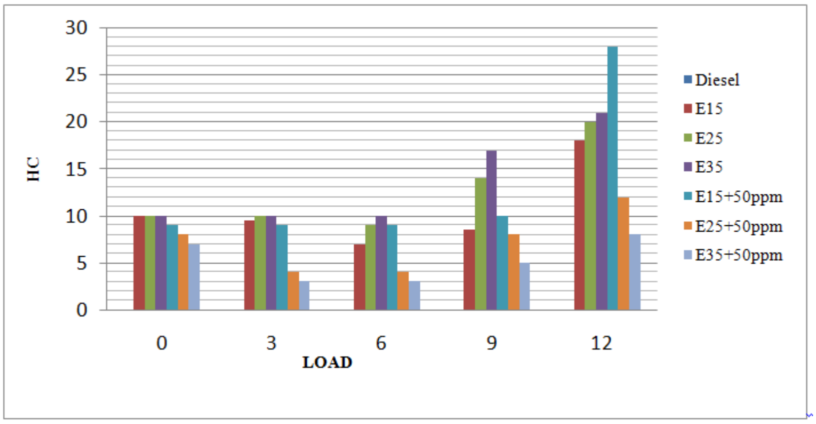

Figure 11: Load vs. HC Emission

CONCLUSIONS

The proposed work was conducted on the performance and emission characteristics of diesel engines, at different loads by using the fuel blends. The operating speed of an engine was 1500rpm. From final test results, the following conclusions are drawn.

- Normal butanol (5%) was added to the diesel-ethanol blends, with and without the use of nano additives. N-butanol is used to prevent the phase separation between diesel and ethanol.
- The brake thermal efficiency of the engine was increased in diesel-ethanol blends with nano additives, compared to neat diesel and other blends.
- Specific fuel consumption is a little increase with and without the additive of nano particles of diesel-ethanol blends.
- CO emission of the engine ran above half loads are lower for diesel ethanol blends, compared to diesel and nano additive blends of diesel–ethanol.
- Nitrogen oxide emissions are reduced in diesel-ethanol blends, at lower loads.
- HC emissions are reduced for diesel-ethanol blends with nano blends, compared to neat diesel and other blends.

REFERENCES

1. *D.C. Rakopoulos, C.D. Rakopoulos, "Effects of ethanol–diesel fuel blends on the performance and exhaust emissions of heavy duty DI diesel engine", Energy Conversion and Management, 49,(2008):3155–3162*
2. *Jincheng Huang, Yaodong Wanga," Experimental investigation on the performance and emissions of a diesel engine fuelled with ethanol–diesel blends", Applied Thermal Engineering,29, (2009): 2484–2490*
3. *T. Shaafi, R. Velraj "Influence of alumina nanoparticles, ethanol and is opropanol blend as additive with diesel-soybean biodiesel blend fuel: Combustion, engine performance and emissions", Renewable Energy,80, (2015): 655-663*
4. *V. Arul Mozhi Selvan, R. B. Anand, "Effects Of Cerium Oxide Nano particle addition in Diesel and Diesel-Biodiesel-Ethanol blends onthe Performance and emissions characteristics of a CI engine" ,ARPN Journal of Engineering and Applied Sciences, Vo. 4, No.7,(2009):ISSN 1819-6608*
5. *S.P. Venkatesan, "Influence of Aluminum Oxide Nanoparticle Additive on Performance and Exhaust Emissions of Diesel Engine", American-Eurasian Journal of Scientific Research, 10 (2), 88-92, (2015): ISSN 1818-6785*
6. *A.Selvaganapthy, A.Sundar, "An Experimental Investigation to Study the Effects of Various NanoParticles with Diesel on Di Diesel Engine", ARPN Journal of Science and Technology,Vol.3,No.1,(2013):ISSN 2225-7217*
7. *Pallavi Ghogare, Dr. N. W. Kale "Experimental Investigation on Single Cylinder Diesel Engine Fuelled With Cotton Seed Biodiesel Blends With Nano Additives", International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT),(2016)*
8. *Rao, M. Srinivasa, N. Venkatesh, and A. Lakshumu Naidu. "A Review on Performance of Diesel Engines by using Biodiesel blends from Different oils."*
9. *Nithin Samuel, Muhammed Shefeek K, "Performance and Emission Characteristics of a C.I Engine with Cerium Oxide Nanoparticles as Additive to Diesel", International Journal of Science and Research, Volume 4 Issue 7, (2015): ISSN: 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438*
10. *N. VENKATESH, M. SRINIVASA RAO & A. LAKSHUMU NAIDU, EVALUATION OF HIGH SPEED DIESEL ENGINE PERFORMANCE ANDCHARECTERISTICS OF ITS EMISSIONS WITH CARBON NANOTUBES ADDEDETHANOL-DIESEL BLENDS, International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)ISSN (P): 2249-6890; ISSN (E): 2249-8001, Vol. 7, Issue 4, Aug 2017, 439-446.*
11. *B. Prabakaran, Anurag Udhoji, "Experimental investigation into effects of addition of zinc oxide on performance, combustion*

and emission characteristics of diesel-biodiesel-ethanol blends in CI engine", Alexandria Engineering Journal , 55, (2016): 3355–336

12. *N. Madhan Raj, M. Gajendiran, "Investigation on aluminium oxide nano particles blended diesel fuel combustion, performance and emission characteristics of a diesel engine", Journal of Chemical and Pharmaceutical Research, 8(3), (2016); 246-257, ISSN: 0975-7384*
13. *N. Venkateswara Rao, M. V. S. Murali Krishna & P. V. K. Murthy, Comparative Studies on Exhaust Emissions and Combustion Characteristics of Tobacco Seed Oil in Crude form and Biodiesel form in Direct Injection Diesel Engine, International Journal of Mechanical and Production Engineering Research and Development (IJMPERD), Volume 3, Issue 4, September - October 2013, pp. 129-142*
14. *S.Ch. Rao, M.Srinivasa Rao, "Performance Analysis of DI Diesel Engine Fuelled with Diesel along with Nano Additives", International Journal of Engineering Trends and Technology, Volume 24, Number 2,(2015);ISSN: 2231-5381*
15. *Muddada Venkatesh, K., and A. Lakshmu Naidu. "ANALYSIS FOR NATURAL CIRCULATION LOOPS." Asia Pacific Journal of Research ISSN (Print) 2320: 5504.*
16. *Gurinder Singh, Sumeet Sharma, "Performance, Combustion and Emissions Characteristics of CI Engine Using Nano-Fuel: A Review", International Journal Of Engineering Sciences& Research Technology, 4(6)(2015): ISSN: 2277-9655 Publication Impact Factor: 3.785*
17. *Naidu, A. Lakshumu, and PSV Ramana Rao. "A Review on Chemical Properties of Biodiesel from Sorghum Oils."*